New Advances in Magnetic Resonance Imaging of Prostate Cancer

ESSAY

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BY

Mohamed Samy Said El-Azab
M.B., B.CH.
Cairo University

Supervisors

PROF. SAMEH ABDEL-AZIZ ZAKY HANNA
Professor of Diagnostic Radiology
Faculty of Medicine
Cairo University

PROF. MAHA HUSSEN HELAL
Professor of Diagnostic Radiology
N.C.I
Cairo University

DR. Naglaa Mohamed Abdel Razek
Assist. Professor of Diagnostic Radiology
Faculty of Medicine
Cairo University

Faculty of Medicine
Cairo University
2008

ABSTRACT

Prostate carcinoma is the second most frequent cause of cancer-related death in men. MR imaging, with T2-weighted scans, MR spectroscopy, dynamic contrast enhancement and diffusion weighted imaging is seen as a method that can improve prostate cancer detection, characterization, staging, and treatment follow-up.

Key word:

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LIST OF ABBREVIATIONS

3D	*Three Dimensional*
3D MRSI	*Three Dimensional Magnetic Resonance Spectroscopy Imaging*
AAH	*Atypical Adenomatous Hyperplasia*
ADC	*Apparent diffusion coefficient*
AUC	*Area under the receiver operating characteristic curve*
BAC	*Body-array coil*
BASING	*Band-selective inversion with gradient dephasing*
BPH	*Benign Prostatic Hyperplasia*
C/C	*Choline to creatine*
CART	*Classification and regression tree*
CC/C	*Choline-creatine–to-citrate ratio*
CG	*Central gland*
Cho	*Choline*
CI	*Confidence interval*
Cit	*Citrate*
Cr	*Creatine*
CZ	*Central Zone*
DCE MRI	*Dynamic Contrast Enhanced Magnetic Resonance Imaging*
DRE	*Digital rectal examination*
DW	*Diffusion weighted*
ECE	*Extra Capsular Extension*
En MRI	*Endorectal coil Magnetic Resonance Imaging*
ERC	*Endorectal coil*
FDG	*Fluorodeoxyglucose*
FLASH	*Fast low-angle shot*
FOV	*Field of view*
FSE	*Fast Spin Echo*
GRASS	*Gradient-recalled acquisition in the steady state*
HGPIN	*High-grade prostatic intraepithelial neoplasia*
LN	*Lymph Node*
LNM	*Lymph node metastasis*
Lt	*Left*
Min	*Minute*
MIP	*Maximum intensity projection*
MRI	*Magnetic Resonance Imaging*
MRSI	*Magnetic Resonance Spectroscopy Ima*

NPV	*Negative predictive value*
NVB	*Neurovascular Bundle*
OCPC	*Organ confined prostate cancer*
PA	*Polyamine*
PACS	*Picture archiving and communication system*
PCa	*Prostate Carcinoma*
PIN	*Prostatic Intraepithelial Neoplasia*
PNI	*Perineural invasion*
PPA	*Pelvic phased array*
PPV	*Positive predictive value*
PRESS	*Point resolved spectroscopy*
PSA	*Prostatic Specific Antigen*
PZ	*Peripheral Zone*
RF	*Radiofrequency*
ROC	*Receiver operating characteristic*
ROI	*Region of interest*
Rt	*Right*
SE	*Spin echo*
Sec	*Seconds*
SI	*Signal intensity*
SNR	*Signal-to-noise ratio*
STEAM	*Stimulated echo acquisition mode*
SUV	*Standardized uptake value*
SV	*Seminal vesicle*
SVI	*Seminal vesicle invasion*
TE	*Echo time*
TEıff	*Effective Echo time*
TIC	*Time Intensity Curve*
TR	*Repetition time.*
TRUS	*Transrectal Ultrasound*
TZ	*Transitional Zone*

INTRODUCTION

Carcinoma of the prostate is an important health problem ***(Engelhard et al, 2000).***

Prostate carcinoma is the second most frequent cause of cancer-related death in men. The increase in the number of the aged, as well as the advent and the ever more frequent use of the prostate-specific antigen serum test for detection, has resulted in an increase in prostate cancer incidence. ***(Fütterer et al., 2005)***

The major goal for prostate cancer imaging in the next decade is more accurate disease characterization through the synthesis of anatomic, functional, and molecular imaging information***. (Hricak et al., 2007)***

Localization of prostate cancer is important given the emergence of disease- targeted therapies, such as intensity- modulated radiation therapy, interstitial brachytherapy, and cryosurgery, as part of patient care. Knowledge of the tumor location within the prostate can help direct maximal therapy to the largest focus of tumor while minimizing damage to the surrounding structures, such as the neurovascular bundles, the rectal wall, and the neck of the bladder. ***(Haider et al., 2007)***

It is unfortunate that there is no single imaging method that embodies all of the optimal characteristics for the integration of diagnostic and interventional procedures for prostatic cancer detection and staging***. (Atalar and Menard, 2005***

These modalities are ultrasound based (including color Doppler Ultrasonography, ultrasound contrast agents, and harmonic ultrasound imaging), MR based including (dynamic MR contrast imaging, MR spectroscopy and Diffusion weighted MR imaging). ***(Oyen , 2003).***

Routine tools for early diagnosis and localization of cancer within the prostate include digital rectal examination and assessment of serum prostate-specific antigen followed by transrectal ultrasonographically (US) guided biopsy. ***(Testa et al., 2007)***

TRUS being widely applied can provide a complete overview of the prostatic zonal anatomy as well as that of the bladder and seminal vesicles. Hence, visualization and sometimes diagnostic information on many pathological conditions of the prostate. (***Patel and RicKards, 2002).***

However, ultrasound techniques suffer from several disadvantages e.g. being subjective, nonspecific and inaccurate in staging***. (Oyen, 2003).***

The sensitivity of systematic sextant ultrasonography (US)-guided biopsy for prostate cancer detection is low (39%–52%) because more than 40% of prostate cancer lesions are isoechoic and central gland tumors are difficult to detect. Use of magnetic resonance (MR) imaging may result in higher localization rates. ***(Fütterer et al., 2006)***

Magnetic resonance (MR) imaging has shown great promise as a noninvasive diagnostic tool in the evaluation and management of prostate cancer. By aiding in the detection, localization, and staging of prostate cancer, multiplanar T2-weighted endorectal MR imaging can facilitat
more appropriate treatment selection and planning. However, for distinguishing prostate cancer from nonmalignant tissue, T2-weighted

MR imaging has high sensitivity but low specificity. To further improve the specificity and sensitivity of MR imaging, functional MR imaging techniques such as three dimensional (3D) hydrogen 1 (1H) MR spectroscopic imaging, dynamic contrast material enhanced MR imaging, and diffusion-weighted imaging have been proposed**. *(Mazaheri et al., 2008)***

Furthermore, MRI has been used for follow-up of prostate cancer after irradiation therapy, hormonal ablation, and cryosurgery**. *(Graser et al., 2007)***

Previous studies involving the use of T2-weighted imaging revealed accuracies of 67%–72% in tumor localization. ***(Fütterer et al., 2006)***

Metabolic information from 3D 1H MR spectroscopic imaging has been shown to improve tumor localization and volume estimation with MR imaging and to provide valuable information about the aggressiveness of prostate cancer**. *(Mazaheri et al., 2008)***

The addition of MR spectroscopic imaging has resulted in a 90% positive predictive value for the sextant localization of tumors in the peripheral zone of the prostate gland. ***(Fütterer et al., 2006)***

The addition of diffusion- weighted imaging to conventional T2-weighted MR imaging has been found to improve the detection of prostate cancer. ***(Mazaheri et al.,***

Dynamic contrast material–enhanced MR imaging is reported to be an effective tool in visualizing the pharmacokinetics of gadolinium